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THE

AËRONAUTICAL JOURNAL.

A Monthly Illustrated Magazine devoted to all subjects connected with the Navigation of the Air.

EDITED FOR THE

COUNCIL OF THE ROYAL AËRONAUTICAL SOCIETY

BY

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Notices of the Royal Aëronautical Society.

Obituary.

We greatly regret to record the death, from influenza, on February 24th, of Mr. Walter Lewis Wade, Member.

The Annual General Meeting.

The Annual General Meeting of the Society will be held on Wednesday, April 2nd, at the Offices of the Society at 5.0 p.m. Nominations of candidates for election to the Council must be sent to the Secretary on or before Wednesday, March 12th. Nominations should be signed by the voters proposing them and should be accompanied by an intimation in writing by the candidate that he is willing to serve.

Demobilisation.

The Council has appointed a representative Committee to consider the position of demobilised officers and men of the Royal Air Force who are members of the Society, to report on the educational facilities necessary for air engineers, and on the existing facilities for instruction in aeronautical engineering.

Exhibit of Enemy Aircraft.

By request of the Air Council the Society undertook the distribution of a considerable quantity of enemy air material. The exhibits have been given to the Society in trust and have been loaned by them to a number of Town Councils and Technical Colleges.

Manchester Branch.

The Second Meeting of the Manchester Branch of the Royal Aëronautical Society was held in the College of Technology on November 26th, 1918, at 7.30 p.m., Professor Haldane Gee presiding. The Minutes of the Inaugural Meeting were read by the Hon. Secretary for the benefit of a number of the members who were not present at that meeting, held on November 12th.

The CHAIRMAN said that he had been interested in the application of optical methods to stress problems for some years, and was sure that the application of such methods to aeronautical problems would be extremely interesting.

Major LOW then delivered his lecture on "Stress Optical Experiments."

In conclusion, the LECTURER drew attention to the discrepancies between the results obtained from the calculated and optical methods, and expressed his willingness to answer any questions that members of the audience wished to ask.

Mr. H. E. BROADSMITH asked how he accounted for the variations in the point of inflection, and if this variation was not due to the method of fixing at the points of support, since these points had been assumed as pin-joints in the calculations. This would no doubt account, to some extent, for the points of inflection coinciding at the higher loads due to the fixed effect becoming less apparent under distortion; also if there was any offset pull of bracing wires which had not been allowed for in the calculations.

Lieutenant A. W. HOLDEN, R.A.F., asked if it would not be possible to use smaller nicols and make the apparatus more suitable for commercial purposes by using monochromatic light and calibrating the eyepiece for rotation against the standard stressed sample.

Mr. BROOKS asked if the local distortion of the light beams near the bolt holes was not excessive. One would have expected the stress to have been more distributed by the socket plates.

The CHAIRMAN said that the optical methods used by Major Low should have great value in the design of machines, but considered that this method ought to be brought into practical use in the research departments of the engineering works. The chief difficulty, however, in constructing the apparatus was in obtaining Iceland spar with which to make nicol prisms. Polarisers and analysers made of thin sheets of glass might be substituted. The coloured lantern slides shown by Major Low were excellent representations of the interference curves and colours. It would be of interest to make additional experiments with the xylonite at temperatures higher and lower than that of the room in which the tests had hitherto been carried out. This experimental method, which revealed the nature of the strains produced, is of the greatest assistance in testing the mathematical theory of the subject.

Major LOW, in replying to the questions, said that with regard to the discrepancy between the calculated and optical methods, the question was being gone into by the Air Ministry's Technical Staff. With reference to the offset pull on bracing wires, there was none in this case, since the line of bracing passed approximately through the centre of the spar at the point of attachment.

Professor GEE then offered to arrange a demonstration of polarisation apparatus for the following week at the College. This was attended by many members. The effects produced by glass under stress and the optical properties of mica, xylonite, and other crystals were shown on a screen. He also exhibited effective and simply-constructed polarisation apparatus for eye observation.

MEDICAL ASPECTS OF AVIATION.

BY L. E. STAMM, B.A., B.SC., M.D., R.A.F.

In venturing to enter this arena of the aviation world I am fully aware that I am guilty of no small amount of temerity, because in comparison with many of my audience I am a very raw recruit, both as an aviator and as a medical officer in the R.A.F. I can only plead in excuse for accepting the kind invitation of your Secretary to address you this evening that I have done a good deal of hard thinking on the subject in the time at my disposal and have obtained some experimental results which appeared of interest to others qualified to judge; and further, it is only by free ventilation and discussion of one's ideas that progress can be obtained in such a new field of science as aviation.

The title of my lecture is a somewhat wide one, but although I shall briefly allude to the many problems that aviation offers to medical science, I would say at once that my own work, to which I shall give special attention, has been to endeavour to determine the essential *mental* qualities of a good pilot, and, more especially, of a good pilot for war service, and by what means and methods the presence of those qualities can be tested in candidates for air service.

I propose, therefore, to take a brief survey of the necessary physical qualities to meet the special conditions of stress and strain in the air, and then deal with the mental qualities in more detail.

In estimating the efficiency of a man for aviation, either physically or mentally, we must view him as a highly complex piece of machinery which, to work efficiently, must be sound in all its parts. He is the governing mechanism superadded to the flying machine. The aeroplane is but the wings of the human bird. And by far the most important part of this human mechanism is the all-controlling central nervous system. Its importance can only be gauged when it is realised that it not only underlies and is closely connected with all the mental functions, but through it are carried out all the fine adjustments and controls of the internal organs, such as the circulatory and respiratory systems, by which they are able to meet any special stresses and strains put upon them, such as those of rapid ascents and great heights, or of centrifugal force in vertical turns. To meet these special stresses we not only require healthy organs, such as heart and lungs, but we must also be able to test for a sound, vigorous nervous mechanism controlling those organs.

When a person assumes suddenly an erect from a prone position a highly complex piece of adjusting mechanism is put in motion, by which blood vessels in one part of the body are caused to dilate and in another to contract, so that the distribution of blood over the body is adjusted to the new position in relation to gravity, and especially the supply of blood to the brain maintained. It is failure to execute this adjustment quickly and accurately that may lead to giddiness or even insensibility. How much more accurate and quick must be the adjustment of this mechanism in the air, with all the sudden changes in relation to gravity and centrifugal force, and in the case of rapid climb or descent, the sudden changes in the air pressure and consequent oxygen supply. All these make demands on the controlling nerve mechanism for rapid adjustment as severe as the demands on the organs (especially respiratory and circulatory) themselves.

Special Physical Conditions of the Air.

The physical conditions in the air responsible for extra stress and strain are:—

1. Height.
2. Centrifugal force.
3. Equilibrium.

1. *Height.*—Height is accompanied by rarefaction of the air and consequent diminished supply of oxygen. This necessitates an increase in the respiratory rate in order to compensate for the diminished supply of oxygen in each breath and also an increased heart rate in order to circulate more rapidly the blood which now carries less oxygen. All this requires not only sound heart and lungs with ample reserve force, but a good controlling adjusting nerve mechanism. This is especially seen in the fact that many pilots can attain good heights provided they do not climb too rapidly. The more rapid the ascent, the greater the strain on this adjusting mechanism.

To Colonel Flack is due the credit for having successfully dealt with this medico-aviation problem. He has devised special apparatus and methods by which prospective pilots can be tested on the ground for their capacity to meet the strain of high flying, so that one is able to classify them for work up to a certain height. One of these tests especially discloses any weakness in the controlling nerve mechanism. It consists in taking the time during which a person can exercise an expiratory force against a column of mercury, and at the same time watching variations in the pulse during the effort. A certain normal standard has been established, and anyone falling below that standard is rejected for the Air Force.

2. *In regard to centrifugal force,* it has been estimated that the centrifugal force to which the aeroplane and the pilot are subjected in a vertical turn may amount to as much as four times that of gravity. That means that in pumping blood up to the brain the heart has to overcome a force four times that of gravity. If the heart is unable to do this, anæmia of the brain and insensibility follow. In order to meet successfully this extra demand on the power of the heart, there must be a full reserve of strength in the cardiac muscle and a good controlling nerve mechanism. Turning chairs have been devised by which candidates for aviation can be tested for their ability to withstand the centrifugal force to which they are likely to be subjected in the air, and in America every prospective pilot is put through this test, but it has not been thought necessary to adopt such measures in this country, as a heart that can support the height tests I have already referred to is found able to meet the demands due to centrifugal force.

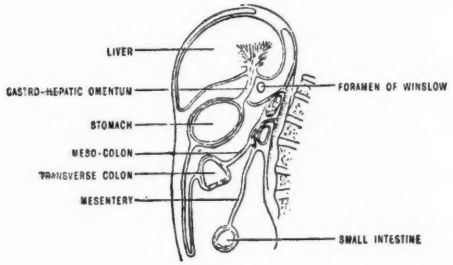
3. *Equilibrium* depends upon many factors, both physical and mental. There is a special sense of equilibrium connected with the sense organ of hearing, but also any failure of adjustment of the nerve mechanism controlling the circulatory system is likely to upset this sense of equilibrium. The turning chair tests this power of the individual to maintain his sense of equilibrium under difficult conditions, but there are also several simpler tests which are applied in the course of medical examination in this country.

Air sickness is probably connected with some weakness in this controlling sympathetic nerve mechanism, although there are probably more factors than one involved and different in different cases. Air sickness is not the same as sea sickness. Many bad sailors suffer no inconvenience in the air. It is much less common than sea sickness, and usually only manifests itself on stunting. In many cases the emotion of fear is an important factor, and in most air sickness is an indication that the man is constitutionally unfit for the job, and therefore it is undesirable that he should persevere to overcome it. Apropos of sickness, it can easily be explained anatomically why one feels a sudden movement down-

wards much more than a sudden movement upwards. The viscera are slung to the back abdominal wall by bands of tissue, called the mesentery. In a sudden movement downwards the viscera do not take up the motion of the body at once, but lag behind and float upwards, causing the " jump " in the inside. In a sudden movement upwards the membrane by which the internal organs are slung is simply put a little on the stretch. On this account, a stalling turn or a sudden dive causes the maximum of sensation, whereas a loop causes no sensation, the mesentery being on the stretch all the time.

On the Continent observations have been made upon the circulatory system in the air at different heights. I had hoped to carry out a series of similar observations myself as it does not follow that one would obtain the same results with British pilots. Under war conditions it was not easy to have a suitable machine at one's disposal and since the armistice weather conditions have not been propitious. Such observations might prove of considerable interest.

Section of ABDOMEN showing Viscera slung by Mesentery



Mental Qualities.

We now come to the mental qualities, but we must first refer to the nerve mechanisms which subserve the mental functions. We have in the first place the sense organs of sight, hearing and touch, also the muscular sense and sense of equilibrium. It is most essential that each one of these senses should function in a normal manner, and they are all tested in the course of medical examination.

A special visual defect has been brought to light in relation to aviation, known as heterophoria, and consisting in a failure of adjustment between the two eyes under conditions of strain, so that monocular takes the place of binocular vision. This lack of perfect binocular vision interferes with accurate judgment of distance in space and may cause an otherwise good pilot to make bad landings. We owe to Major Clements the discovery of this visual defect, and by visual exercises he has succeeded in curing the condition in many cases and has helped in this way to turn out good pilots from hitherto unpromising candidates.

In regard to the motor mechanism, it is important that the muscles show good tone and a power of nice control and adjustment. Deficiency in this respect is usually characterised by the pilot instructor as " heavy on controls." Such natural inherent clumsiness is a bad quality in a pilot, and means have been devised to test for this on the ground; but there is another deficiency which has not received much attention, but which I think is of some importance, and that is " conscious control of the muscles." A Mr. Matthias Alexander has developed the subject, and is disposed to ascribe all the ills of humanity to this lack of " conscious control." It is a fact, although it would be a surprise to most to learn it, that very few pople have full conscious control of their muscles, and it can be demonstrated in this way: If a person is told to

move a limb in any direction he will do so, but if he be told to relax the muscles of any limb so that *you* can move it in any direction he will probably not be able to do so, and the more you ask him to try and relax them the more rigid will the muscles become, while assuring you all the time that they are relaxed. This inability to relax or inhibit muscular contraction shows a lack of conscious control of the motor mechanism, and is a factor of some importance for the pilot. It shows a lack of complete rapport between the muscles and brain nerve centres that should control them. There is a great difference between individuals in this conscious control or lack of it. It is quite simple to test. The person is instructed to lie down on the floor and relax all the muscles of his limbs. One of the limbs is gently raised and then let go. If the limb is really relaxed it will, of course, drop at once, as if lifeless. If, however, as is often the case, the muscles are not relaxed, the limb remains in the air in the position to which it was raised. Some are so convinced that the muscles are relaxed that the limb remains in the air without its possessor realising the absurdity of the situation. Apart from the importance of the general principle of perfect rapport between brain and muscles, this unconscious rigidity may be responsible for a serious condition of things in the air in the course of training, as when a pupil loses his head and hangs on like grim death to the joy-stick, making it difficult or even impossible for the instructor to take proper control.

Inability to relax to an exaggerated extent is significant of a certain tenseness of the whole neuro-muscular system, characteristic of a type of neurotic disposition well known to neurologists and unsuitable for aviation.

In my medical inspections of pupils at the aerodrome I used to test for this ability to relax and give directions for practice to obtain a proper control of the muscles and to be able to relax at will. I would suggest that some such instruction should be embodied in the ordinary physical training.

In ordinary flying a pilot of any experience controls his machine automatically—that is to say, his sensations of sight, hearing, and touch giving him the necessary information about his machine are transmited to the nerve centres and the consequent muscular movements are carried out without any interference or control from the higher centres. But in the air circumstances are continually occurring calling for the exercise of the higher centres, connected with decision, discrimination, judgment, in the most rapid and definite manner. At certain times rapid action following quick and right judgment decides his fate. Above all things, one requires for a good pilot a mental constitution that has the capacity to take in all the circumstances of a situation quickly and correctly and make a rapid and correct decision. When the engine conks the experienced pilot automatically puts the nose of the machine down and looks to his pressure gauge, and with his conscious mind looks around and takes in the conditions before him for a forced landing, and decides upon his course of action. For the inexperienced pilot some of the necessary actions, such as observation of pressure gauge, may not be automatic, so that there is still more to occupy the conscious mind.

For all this one requires not only a quick and accurate co-ordination between the senses and the muscles, but also between these and the higher mental functions.

A quick co-ordination between the senses and the muscles can be tested by taking the "simple reaction time," that is the interval of time that elapses between a person receiving a signal, either visual, auditory, or tactile, and his response to the signal, in the form of some movement, such as pressing an electric key. In my opinion testing for this "simple reaction time" is of little or no practical value for the air service, because in healthy young men with normal senses and muscles, the co-ordination between these and therefore the "reaction time" is sufficiently quick and accurate for all practical purposes, and in actual experience I have obtained some comparatively slow reactions from

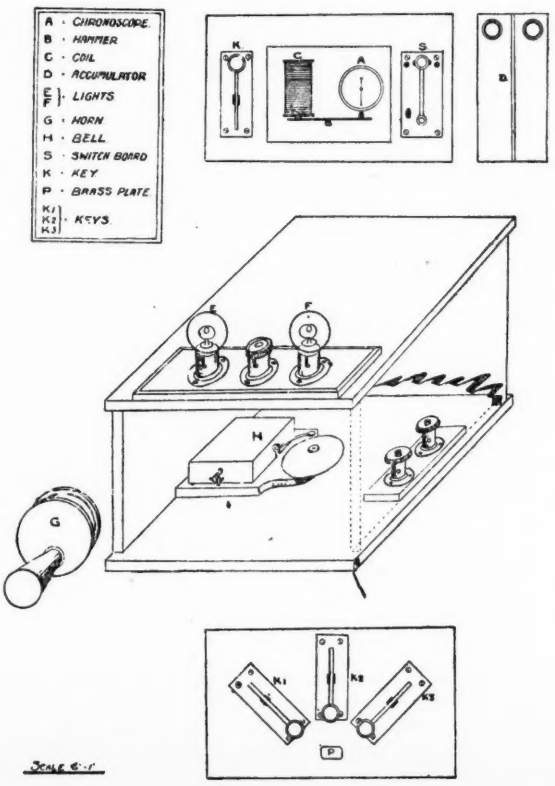
very capable individuals and very quick responses from some of poor mentality. In candidates for the air service I do not think these simple reaction time tests would eliminate one per cent. of undesirables.

What one requires to test is the ability of the candidate to respond quickly and accurately under conditions in which the higher *conscious* mental functions of discrimination, decision and judgment are involved. For this purpose one has a number of different signals, requiring different responses, the candidate not knowing which signal to expect. This necessitates the intervention of the conscious mind between the perception of the signal and the motor response and consequently the reaction time is lengthened. The mental ability is tested by the rapidity and accuracy of response in proportion to the complexity of the problem presented to the candidate.

Many forms of apparatus have been devised, but as the interval of time is only a fraction of a second and variations are measured in 1/100ths of a second, some difficulty has been found in obtaining accurate and reliable apparatus that is also sufficiently simple for practical purposes.

With the help of Major Burgess, engineer, R.A.F., I have devised an apparatus which is comparatively simple and which in practice has proved of value in testing candidates for the air service. A diagram of the apparatus is shown below.

Diagram of Reaction Apparatus.



Reaction Time Apparatus.

It consists of a chronoscope A, which registers to 1/100 second, and is worked electrically by a hammer B, from a coil C, and accumulators D. There are four signals, two differently coloured lights E and F, an electric horn G, and an electric bell H. The operator has a switchboard S, by which any of the signals is put in the current, and the signal is given by touching the key K. The candidate sits opposite the operator and places his right-hand first finger on the brass plate P, which is equidistant from the three keys K_1, K_2, K_3. The end keys, K_1 and K_3, are for the corresponding lights, and the middle key, K_2, is for the horn or the bell. It was not considered desirable to complicate things to the extent of four keys.

When the operator presses his key K one of the signals is given and at the same time the chronoscope starts. The candidate responds by touching the appropriate key, K_1, K_2 or K_3, which stops the chronoscope and the reaction time is read off in 1/100th seconds.

The method of examination is as follows:—After a short preliminary rehearsal to acquaint the candidate with the method of working the apparatus, the candidate is tested for the simple "automatic reaction time" by one signal, which he knows beforehand. He is tested in this way by a series of each of the four signals. As already stated, I set no value on these tests, but they enable the candidate to get used to the apparatus. After testing for the simple reaction time with each separate signal the candidate is now told that he may get either one of the two lights and he is to respond by touching the appropriate keys K_1 or K_3. Having done a series of ten with the two light signals, he is now given a series with three possible signals, the two lights and the horn, and finally a series of all four signals—two lights, horn and bell—but for the bell for which he has previously used the middle key, K_2, he is now told to keep his finger on the brass plate. This involves mental inhibition. Each series shows an increase in the reaction time, owing to the increased complexity of the problem before the candidate. Recently I have used a further series of four signals, in which the keys previously used for the lights, each corresponding to the light on the same side, are now reversed. This further complicates the problem and causes a further increase in the reaction time.

The following are the averages of 150 cases, including pupils and instructors (good pilots), for the different tests in 1/100th seconds:—

(1)	Reaction time to single light signal	28
(2)	,, ,, ,, sound ,, ...	26
(3)	,, ,, two lights	35
(4)	,, ,, ,, ,, and horn	38
(5)	,, ,, ,, ,, ,, two sound signals ...	44
(6)	,, ,, four signals with keys to lights crossed	48

Examination of 20 instructors (experienced pilots) in the same way yields, as would be expected, appreciably lower figures as averages for the 20 cases:—

Simple visual reaction (one signal)	27
,, auditory ,, ,, ...	25
Two signal test (two lights)	32.4
Three ,, ,, (two lights and horn)	34.5
Four ,, ,, (two lights and two sound signals) ...	40.4
,, ,, ,, (with keys and lights crossed)	46

Taking the last two tests as the crucial tests of the mentality of the pupil, I have found a remarkable correspondence between the results and their capacities as flying pupils. Having tested a certain batch of pupils, I send the names to their instructors and ask for their opinion as to their flying capacities and possibilities of making good pilots. Arranging them in the order of the results

from the machine, as a general rule the top names have "very good" or "good" against them, the middle ones "fair" or "average," and the bottom ones "poor" and probably "turned down" or sent to "heavier machines."

Appended is a list of pupils examined, with the results of the test and the criticisms of their instructors, from which the value of the test can in some measure be estimated.

I should point out that with my apparatus there is a muscular adjustment involved in the movement of the finger to the different keys. In my opinion this is a valuable factor as a further test of the nerve mechanism, but it necessarily prolongs the reaction time, so that even the simple reaction time with my apparatus is longer than the usual without such muscular adjustment. It is quite easy to dispense with this for simple reaction to one signal by placing the finger ready on the key.

The value of the tests lies in the fact that they involve considerable adjustment and co-ordination between the senses and the muscles and at the same time call for a rapid and accurate working of the higher mental functions of conscious discrimination and decision, a complexity of conditions similar to that involved in piloting an aeroplane.

Moreover, it calls for a prolonged effort of attention and the ability to sustain the effort is shown by the way in which a candidate succeeds in keeping up his rate of response to the end of the tests or shows evidence of mental fatigue by sudden lengthening of the time intervals or by mistakes in the keys.

Over and above everything else there is the "will" factor to be taken into account. This may act in at least two different ways. It may be negative. Then the results of the tests will not represent the best that the candidate can do. Or it may be very positive. It may be exercised to such an extent that the candidate exceeds for a time his normal power of reaction. In this case the excess of his efforts usually shows itself by mental fatigue setting in before the tests are finished, and he is unable to keep up the pace he has set for himself. All these variations are very useful to observe in forming an estimate of the candidate's mental constitution and capacity.

I would, in fact, claim for the apparatus that it not only gives figures of some value for estimating the mental capacity of a candidate for aviation, but that it affords a means of employing a candidate in a way which gives considerable opportunity of making mental notes in regard to his intelligence and personality, by the manner in which he tackles the machine. Some tumble to the game at once and show a remarkably quick adaptability, whereas others are equally slow in picking up the idea, but may warm up as one proceeds and give quite a good account of themselves in the final tests. Some are light in touch and accurate; others heavy and clumsy, so that they often miss the keys and almost break them when they touch them. I have myself been surprised in dealing with pilots personally known to me to observe how the machine seems to bring out and record their personality, and especially their flying personality. There appear to be two good but different types of mentality which react differently to the apparatus. In the one the reaction times are very quick, but in cutting down the time allowed for discrimination to the utmost in the final tests several mistakes may be made. In the other good type the reaction times are appreciably longer, perhaps even above the average, but the signals are responded to with absolute accuracy. The flashy, crack scout pilot shows the first type of reaction, while the steady, careful pilot is characterised by the second type of reaction.

Any flying man may say, "These tests may be very good, but even if a man has ever such quick discrimination and judgment, he is no use as a pilot unless he has guts." This brings us to the second important mental factor—the emotional.

The Emotional Factor.

We can distinguish two extreme types—one in which disturbance of these centres, by some emotion, whether that of fear, anger, sorrow or joy, causes a most profound effect upon the rest of the nervous system, resulting in rapid heart action and other disturbances of the circulatory system, rapid respiration or temporary stoppage of same, tremors of the muscles, and an upset of the digestive system; and all this bodily disturbance may be accompanied by an inhibitory effect upon the higher nerve centres, so that the processes of thought, judgment, discrimination, and action are paralysed. In such a type it does not matter a straw whether under normal conditions the individual can think, decide, and act quickly or slowly, because when he is emotionally disturbed by, say, impending danger, his mental processes are paralysed and his bodily functions are so disorganised that his machinery is out of control. In the other type the emotional centres are so stable that no such disturbances to the rest of the machinery take place, even under the most trying conditions. There may be, and almost certainly is, some activity of these emotional centres set up, but this results in a stimulation of the rest of the mechanism, so that his powers of thought and action are actually increased. One has here a striking analogy between the effect of the emotional centres upon the rest of the nervous system and that of drugs; all drugs such as alcohol, opium, and the anæsthetics that have the power of affecting specially the nervous system first stimulate it to greater activity and then paralyse it. If the dose is small the effect is chiefly that of stimulation and the period of stimulation may be of some duration, but if it be large the period of stimulation is very short, or non-existent, and the chief effect is that of paralysis. The difference in emotional effect is again exemplified in artistic performers. In some the emotional disturbance of fear is so great that they are unable to perform in public. In others the emotion serves as a stimulus to help them to do their best. It is obvious that the individual who is liable to such serious emotional disturbances or, in the language of the Service, liable to get the "wind up," is constitutionally unfitted for work in the air. And here I would point out that such a person is not necessarily a coward in the ordinary acceptation of the term. The condition is constitutional. He may have the mental "guts," the will-power to force himself to incur any risks. He may have proved himself an excellent infantry officer and go into the Air Service with all the desire and determination to win laurels by bringing down Huns in the air, but when he finds himself in the position of danger that he has voluntarily incurred he is handicapped by these emotional disturbances and is not likely to do the best for himself. There are, of course, many intermediary conditions between the extreme types I have depicted, with a certain average, but it is most important that we should be able to eliminate at least individuals in whom the tendency to severe emotional disturbance is likely to manifest itself. Various tests have been devised, the principle of which consists in trying to arouse the emotion of fear by some sudden and alarming noise, such as a pistol shot, and testing the bodily reactions, such as increased heart action, muscular tremors, etc. The artificiality of the conditions somewhat vitiates the results.

I have found that the pulse rate under ordinary medical examination is a very fair guide to detect the "windy" type. People who manifest their uneasiness at coming before a doctor for examination by a rapid pulse, which does not settle down in spite of every effort to put them at their ease, prove by that fact that there is a lack of control of the nerve mechanism of the vital centres, that there is an instability and liability to serious disturbances by the emotion of fear, and they belong to the "windy" type. This instability does not appear to be in the vital centres themselves, but in the higher nerve centres controlling them, because such individuals respond to the ordinary physical test in a normal manner. The manometer test, the exercise test, show a perfectly normal acting mechanism; it is the rapid pulse of emotional disturbance.

Then there is a typical facial expression which one gets well acquainted with in carrying on this work. It consists in a furtive, apprehensive look, as if always expecting something unpleasant to happen, with a certain look of indecision and uncertainty, in marked contrast to the straight, direct, decided expression of the crack fighting pilot. One cannot say that an amount of "windiness" above the normal may not be present without this obvious expression, but when it is well marked I should have no hesitation in throwing its possessor out as undesirable for the Air Service.

It has been found that the bodily expression of an emotion owing to the disturbances in the circulatory system causes a deflection of a sensitive galvanometer proportional to the disturbance, so that this would appear to offer a means of comparing the extent of emotional instability in different persons. The chief difficulty lies in artificially producing the conditions necessary for calling forth the emotion. To some extent my apparatus is a test of an emotionally nervous instability, because in a highly-nervous person the ordeal of being examined in this way tends to set up a condition of stage fright, and I have had cases in which the startling noise of the horn has shown a paralysing effect by causing a pronounced lengthening of the reaction time to this signal as compared with the other signals. But the apparatus is by no means a satisfactory test for the emotional factor, for in actual practice this emotional factor has been the chief disturbing influence in the results of these tests; pupils giving good results with the apparatus may be marked "poor" by the instructor because they are "windy," and others showing long reaction times may be marked "good" by their instructor because they have "guts"! Very frequently, however, I have also detected these qualities by the tests I have referred to and made notes to the same effect.

Essential Mental Qualities for Aviation.

We have then these two chief mental qualities—quick, accurate judgment and an emotional stability or "guts," or to use the term in a general sense, "confidence." Now, although instructors lay so much stress upon the "guts" of a pupil, disregarding to some extent the intelligent factor and judgment, in my opinion one requires a nice balance between the two. Crashes occur from two chief causes:—

1. "Wind up" or "losing one's head," due to loss of control from emotional disturbance of fear in the manner already described.
2. Over-confidence in an intelligence or judgment which is below the average and which therefore does not justify the confidence.

The one condition is quite as responsible for disasters as the other. I have cases on record that have given poor results with my apparatus, and of whom I have formed an adverse opinion on account of lack of intelligence on general grounds, education, etc., but who have been marked "good" by the instructor because they have "lots of guts." The verdict of my apparatus has been in the end justified because the inevitable crash has come. Above all things, it is necessary that a man should know his own limitations as well as those of his machine.

This power of judgment and quick decision does not appear to involve the highest intellectual functions of the mind; it is rather on a par with what we call "tact" in ordinary life. It is the power to quickly take in all the circumstances of a given position and react to it in the best manner—to do the right thing instead of the wrong with quick decision.

There is a certain type of highly intellectual person who would by no means take first prize at the tests with my apparatus, but also he would not make a good pilot.

While one may in this way pick out special mental characteristics essential for the successful aviator and exclude anyone specially deficient in any one of them from air service, one must at the same time recognise that there is an infinite variety in the temperaments and mental constitutions of men, and that therefore no hard-and-fast line can be drawn. Just as there are many types of aeroplanes, each more or less useful for a particular purpose and in each of which the designer has had to compromise between the lift and the drift or the speed and the climb, so the pilot of cool judgment, though somewhat slow and deliberate in action, is suited for one service, while the quick, high-spirited, though somewhat emotional, erratic type may be chosen for another, such as the fighting scout. In both cases they may be a compromise in comparison with the ideal pilot.

Aviation requires, above all things, a strong, tough nervous system that can withstand all the stresses and strains, both mental and physical, in the air, that controls well the vital organs, reacts to external conditions quickly and accurately, and is not affected detrimentally by emotional disturbances. Just as one uses the term " physique " to the general development of the body and one speaks of good or bad " physique," so I would suggest the expression " nerve physique " to describe the general tone of the nervous system. There is a general consensus of opinion that a good " nerve physique " is found in young men who have led an outdoor life. Outdoor pursuits not only tend to develop such a nerve physique, but also offer in many ways the best training for aviation by developing their power of observation and quick response, as in the case of riding, shooting, hunting, and, though perhaps in a less degree, almost any sport.

Although I must plead guilty to introducing a further piece of testing mechanism in this " reaction time " apparatus, which I believe will prove useful as a means of testing the suitability of candidates for aviation and possibly also as a means of testing for staleness later on when the normal of each individual has been recorded, I would at the same time deprecate too much effort at devising apparatus with a view to imitating the conditions of the air on the ground. It seems to me much more practical and British to adopt what is really the simpler and also much more certain course of taking the candidate into the air. I would suggest that in any air service, and more especially in the R.A.F., much time and money might be saved in the preliminary ground instruction if, from the very outset, at certain testing stations every prospective pilot were given one or more trial trips in the air with specially experienced pilots and under special medical supervision.

The main theme of my discourse is now finished, but I would like to refer to one or two further medico-aviation points that have come up for discussion.

The Fighting Spirit.

In regard to the *Fighting Scout*, it has been suggested that the best type of fighting scout must possess the fighting spirit and be capable of developing the emotion of anger with his foe—in other words, must be able " to see red." With this I disagree. In conformity with what I have already said in regard to the emotions, it is my firm conviction that a pilot requires to be as free as possible from any emotional disturbance, whether of fear or anger, and that if he " sees red " his judgment is liable to be clouded and faulty. I must admit that this is to some extent an armchair opinion, but I have sat in a machine taking part in a scrap many times, and I think I have sufficient imagination to fill in the rest of the picture; and as it appears to me, the fighting scout requires the hunting instinct with all the judgment, cunning, and zest to down his prey, rather than the fighting spirit of " seeing red." It is the man who goes forth in this spirit, aggressive but cool, that is most likely to carry through those nice

turns and twists in the right direction and at the right moment that seal the fate of his adversary and render him the victory.

Alcohol and Tobacco.

Then there is the much-vexed question of alcohol and tobacco. From what I have already said it will be obvious that it is not only necessary for the pilot to possess a good nerve physique, but to keep it up to pitch, and any excess reacts deleteriously upon the nervous system more than on any other part of the body, more especially excesses in drugs such as alcohol and tobacco. It has been seriously suggested that an occasional good " binge " is beneficial and tends to equalise the effect on the nervous system resulting from the strain of continual flying. I do not think such an idea can in any way be supported, either physiologically or from practical experience.

The evidence such as the personal experience of individual pilots is very conflicting, but probably the best that can be said for such " binges " is that some can carry on quite well in spite of them, whereas with others the deleterious effect is quite definite. An athlete who had trained a good deal for boxing, running, and club-swinging told me that a good " binge " lowered his physical fitness for three weeks afterwards. Such a prolonged effect is certainly to be deprecated in conditions where physical fitness is so essential.

Then there is the question of the immediate effect of alcohol upon the pilot. Many pilots will testify to their having done their best flying performances under the influence of more or less alcohol. I have already referred to the fact that all these drugs have a period of stimulation, which may be long or short, according to the dose, disposition of the individual, and other conditions, and this is followed by a stage of paralysis. Now this period of stimulation when the wits are sharpened and the confidence increased is usually short, and in any case cannot be measured and reckoned upon. As a general rule the " Dutch courage," or increased confidence, is of some duration, but the stimulation of the wits is evanescent and soon passes off. We have then a condition of lowered intelligence or power of judgment, etc., combined with increased confidence, *i.e.*, the balance between the two factors, to which I have already referred, is upset—consequently, crash !

Tobacco, and in particular cigarettes, is another snare both for the experienced pilot and for the pupil under instruction. Excess leads to tremors of the hands, rapid pulse and palpitation of the heart, and general loss of tone of the nerve mechanism. It is worth noting that the physical effects are closely analogous to those resulting from the emotion of fear. Now if the physical effects of an emotion be reproduced it is possible for them to call forth the mental state of the emotion. I suggest, therefore, that excess in tobacco by its physical effects may call forth a mental condition very similar to " windiness," and so, in a double way, acts deleteriously upon a pilot.

In thus pointing out the ill-effects of excess in alcohol and tobacco I do not propose to advocate a policy of perfection in the flying world. One may even express some sympathy with indulgences in these poisons, because there is no doubt that, however much flying may appeal to one as a sport, it involves some considerable strain upon the nervous system, and when one is living under some such condition of strain there is always the tendency to these indulgences, but it is undoubtedly the duty of the medical service charged with the care of pilots or would-be pilots, whether military or civilian, to keep a close eye on any excesses and to take such measures as may seem necessary to restrict them.

Nothing will better contribute to this end than the ample provision of facilities for out-of-door sports. More especially I would plead for the provision of horse-riding, both for pilots and pupils under instruction. Horse-riding is one

of the best physical exercises, and probably comes nearer to controlling an aeroplane than any other ground occupation. I would suggest that every aerodrome should have its stables as well as its hangars, and what better plan than an aerodrome for polo!

Furthermore, there is a much greater inclination to indulgence as a means of combating conditions of stress or "staleness" from long service. In my opinion no one should be engaged in continual flying, whether as instructor, ferry pilot, or on active service, for more than three months without a complete rest of at least a couple of weeks.

My survey of the medical research work in relation to aviation other than that in which I have specially been occupied, has necessarily been brief and scrappy, but I think it will be evident that aviation offers a good many problems to medical science and that some progress has been made in their solution. Such progress is not only of value for the aviation world, but also for medical science as a whole. Every time observations are made upon the human mechanism under new conditions, they not only result in rendering assistance to the human mechanism under those particular conditions, but they also throw fresh light upon the working of that mechanism under ordinary conditions. To take but one example among many, we have learnt in regard to the circu'atory system not to consider the heart as an organ by itself and judge a man's fitness by the presence or absence of a "bruit," but to study the circulatory system as a whole and especially the nerve mechanism controlling it. And in regard to my reaction time apparatus, I would suggest that it may not only prove useful as a test for the necessary mental alertness of a pilot, but also might find a sphere of usefulness in testing people for other occupations in which those mental qualities of quick discrimination and judgment are in requisition.

The Medical Service.

In conclusion, I would point out that to the Medical Service falls the duty not only of selecting men specially fitted, physically and mentally, for aviation, but also of keeping them under medical supervision for any signs of stress or "staleness."

For this purpose it is necessary that medical officers of the Service should be versed in conditions peculiar to aviation and also it is most desirable that they should have some practical experience of aviation. Personally I have found my small aviation experience of the greatest value. Moreover, pilots themselves have more confidence in such medical officers, and I think they are right.

In the developments which are likely to take place in aviation in civil life in the immediate future it is to be hoped that those responsible will realise the necessity for the same medical supervision of pilots as in the R.A.F. In a sense the demands upon the "nerve physique" and mental qualities are not so stringent for the ferry pilot as the fighting scout pilot, but, on the other hand, the responsibilities are much greater in having the care of other men's lives in their charge.

FLIGHT GROUP No. I.

Name.	4-signal test in 1/100 sec.	Remarks of M.O.	Instructor's Remarks.
I.	31	Haphazard, W.7.	Good, lacks judgment.
II.	35	Very intelligent and quick.	Very good—now instructor.
III.	35·5	P. 120. Nervy but guts mentally.	Fair—nervy, drinks too much.
IV.	36	Sturdy, sports, W.3.	Good but slow.
V.	38	Sturdy Canadian, horse-riding.	Good, quick, guts.
VI.	39·5	—	Average.
VII.	39·5	All there—guts.	Good—plenty of guts.
VIII.	39·5	Says upset by 3 instructors.	Poor, no guts, gets sick.
IX.	40	No nerve physique.	Average.
X.	41	—	Very good; steady.
XI.	42	—	Good.
XII.	42	Capable, good type.	Extra good.
XIII.	42	—	Average.
XIV.	42	Alert, good type.	Very good—now instructor.
XV.	42	—	Average, just started flying.
XVI.	43	Intelligent.	Good.
XVII.	43·5	Sports, average intelligence.	Fair—guts.
XVIII.	44	—	Average.
XIX.	44·5	Uptake slow.	Good but silly.
XX.	44·5	Lethargic.	Slow but solid.
XXI.	46	Dumpy.	Average, slow.
XXII.	46	Musical, nervy.	Fair.
XXIII.	46	Slow uptake, no sports, clerk.	Average.
XXIV.	47	Slow uptake, no sports, clerk.	Average, slow learning.
XXV.	47	Alert—sports.	Good.
XXVI.	47	Nervy.	Poor—windy.
XXVII.	47·5	Very anxious, W.4.	Average, persevering.
XXVIII.	48	—	Poor—sent to heavier machines.
XXIX.	49	Windy, paralysed by horn signal, bad type.	Poor—windy.
XXX.	50	—	Average, large flying experience.
XXXI.	50.5	Bank clerk, not robust.	Average.
XXXII.	50.5	Bright; guts.	Good—lots of guts.
XXXIII.	50.5	—	Poor. ? Windy. To be turned down.
XXXIV.	52	Slow but good type.	Slow, but will make good.
XXXV.	52	—	Fair.
XXXVI.	52	Sturdy—rough and ready.	Fair—solid—heavy-handed.
XXXVII.	52.5	Slow and dull.	Average to poor.
XXXVIII.	53	Nervy, sick on stunting.	Poor.
XXXIX.	55	Heavy—dull.	Poor—sent to heavier machines.
XL.	55·5	Dull and windy.	Poor—sent to heavier machines.
XLI.	57	—	Poor.
XLII.	75·5	Mentality very poor.	Hopeless.

W. = mistakes in keys.

FLIGHT GROUP No. II.

Name.	4-signal test in 1/100 sec.	Remarks of M.O.	Instructor's Remarks.
XLIII.	33	Journalist, M.A. Alert, no sport.	Good, but previous flying experience.
XLIV.	36.5	Average.	Good.
XLV.	37	Good type.	Very good.
XLVI.	37.5	—	Good—guts—keen.
XLVII.	39	Good type—Canadian.	Very good.
XLVIII.	40	Good type.	Good.
XLIX.	40	Average.	Good.
L.	40	Quick but bumptious and over-confident.	Good but objectionable.
LI.	40.5	—	Average.
LII.	40.5	Heavy Scotch type—guts.	Average, perseveres.
LIII.	41	Good type.	Very good—now instructor.
LIV.	41	—	Good.
LV.	41.5	Average.	Good, slow learning.
LVI.	41.5	Bright and intelligent; guts.	Very good and keen.
LVII.	41.5	Accountant, lethargic and heavy.	Heavy-handed; to be turned down.
LVIII.	41.5	Lack of muscular adjustment.	Poor and slow.
LIX.	42	Good type—sport.	Very good, steady and keen.
LX.	43	? Windy.	Good but windy.
LXI.	43	—	Average, rather slow.
LXII.	43	M.C.	Good but slow learning.
LXIII.	43.5	Heavy.	Good but slow learning.
LXIV.	44	—	Keen but lacks judgment, windy.
LXV.	44.5	Nervous temperament but not windy.	Average, keen, guts.
LXVI.	44.5	Sports, horse-riding.	Average, keen, guts.
LXVII.	45.5	—	Average but slow.
LXVIII.	46	Good type.	Good.
LXIX.	46.5	Good type Canadian.	Good.
LXX.	47	Average.	Good and very keen.
LXXI.	47	—	Average to poor.
LXXII.	48	Little stamina, clerk.	Average.
LXXIII.	48	Average—no sports.	Average.
LXXIV.	48	M.C. slow.	Good guts—slow learning.
LXXV.	52.5	P.96. Tremors, ? windy.	Average—windy.
LXXVI.	49.5	Average.	Slow—improving.
LXXVII.	50.5	Nervy.	Poor—windy.
LXXVIII.	51	Sports.	Poor but guts.
LXXIX.	53	M.C. not good type.	Very slow, to be sent to heavier machines.
LXXX.	53.5	—	Average.
LXXXI.	54.5	M.C. heavy. W.5.	Hopeless, turned down.
LXXXII.	54.5	M.C. heavy.	Poor—very slow.
LXXXIII.	54.5	M.A. Bright. W.4.	Average.
LXXXIV.	56	Slow and dull.	Very poor—turned down.
LXXXV.	57	Windy—bad type.	Poor—heavy-handed.
LXXXVI.	58	Heavy—sports.	Average—guts.
LXXXVII.	58	M.C. but guts, drinks too much.	Average—guts.
LXXXVIII.	61	—	Poor.
LXXXIX.	66	Civil Service clerk.	Poor—slow.

W. = mistakes in keys.

M. = mentality. A. good. B. average. C. poor.
Where not stated mentality is average.

FLIGHT GROUP No. III.

Name.	4-signal test in 1/100 sec.	Remarks of M.O.	Instructor's Remarks.
XC.	34	Alert—bright.	Very good.
XCI.	35	Average.	Average, not keen.
XCII.	38	Canadian, good type, sports.	Very good.
XCIII.	38	Good type.	Very good.
XCIV.	38	—	Average.
XCV.	39	M.A. Good type.	Very good—now instructor.
XCVI.	40	M.A. Rather slow in uptake.	Very good.
XCVII.	40	—	Poor—inattention.
XCVIII.	40	M.A. Alert.	Good.
XCIX.	42	Good type—sports.	Very good.
C.	42	Windy.	Intelligent but no guts.
CI.	42	Artistic. M.A.	Good.
CII.	43	—	Good.
CIII.	43	—	Good.
CIV.	43	—	Good.
CV.	43	—	Fair, lacks confidence.
CVI.	45	Good type—bright.	Good.
CVII.	45	No physique—windy.	Poor, windy and sick.
CVIII.	45	—	Average to good.
CIX.	45	Alert and bright, good physique.	Average to good.
CX.	46	Rough type.	Average to good.
CXI.	46	—	Good.
CXII.	46	Canadian, rather stolid—guts.	Good.
CXIII.	47	Canadian, sports, M.A.	Good but very slow.
CXIV.	47	Stolid but guts.	Good—guts.
CXV.	47	Russian, intelligent.	Average.
CXVI.	48	—	Average.
CXVII.	48	—	Average.
CXVIII.	48	Alert—guts.	Average.
CXIX.	50	M.B. Slow in uptake.	Average.
CXX.	50	—	Average.
CXXI.	50	Slow—stolid.	Good, guts.
CXXII.	50	—	Poor.
CXXIII.	52	Too talkative and plausible, windy.	Average—windy.
CXXIV.	52	Bright and intelligent.	Average.
CXXV.	52	—	Average.
CXXVI.	52	—	Average.
CXXVII.	52	Good type Canadian, sports.	Average.
CXXVIII.	53	—	Average.
CXXIX.	54	—	Poor.
CXXX.	54	M.C.	Average to poor.
CXXXI.	54	M.C. heavy.	Poor.
CXXXII.	55	—	Poor.
CXXXIII.	56	Haphazard, M.C.	Average.
CXXXIV.	56	Rather heavy but good type.	Average slow but solid.
CXXXV.	56	Feeble mentally and physically.	Average to poor.
CXXXVI.	63	Poor type.	Average to poor.
CXXXVII.	63	—	Average.
CXXXVIII.	66	Slow but sturdy, horse-riding.	Average to poor, very slow.
CXXXIX.	68	Charterhouse School, but slow, heavy.	Poor—very slow.

W. = mistakes in keys.

M. = mentality. A. good. B. average. C. poor.
Where not stated mentality is average.

PROCEEDINGS.

SIXTH MEETING, 54th SESSION.

The Sixth Meeting of the 54th Session was held in the Theatre of the Royal Society of Arts, London, on Wednesday, January 15th, 1919, Surgeon-General Sir ALFRED KEOGH, G.C.B., M.D., presiding.

Dr. L. E. STAMM, B.A., B.Sc., R.A.F., delivered his lecture on "Medical Aspects of Aviation."

DISCUSSION.

Lieutenant-Colonel FLACK, C.B.E., R.A.F., said Lieutenant Stamm had done singularly good work, though he described himself as a novice. He might have gone to the French or Italian authorities and "pinched" their apparatus—so to speak—but he had, with his colleague, to all intents and purposes, devised a form of apparatus which was especially his own. He had dealt especially with the reaction time test and given his interpretation of it. As he (Colonel Flack) would perhaps meet our Allies in a short time at a Conference, it might not be well for him to agree altogether with the opinion expressed by Lieutenant Stamm that simple reaction time tests were of value to the degree of 1 per cent. He had not had much experience with them because he had been of the view that it was not necessary to test for simple reaction times themselves, as generally one got good quick reflexes associated with proficiency in sport. He was more or less in agreement with Lieutenant Stamm, however, as to the value of simple reflexes, though one had to bear in mind the great value attached to such by Nepper, Binet, and other authorities in France. He felt that Lieutenant Stamm's "dilemma"—his more advanced tests—were of distinctly greater value. He was greatly impressed by them at first sight, and still more so as the result of this very able address. What they would eventually be able to put candidates through depended a great deal on their physique. Besides being a test of mentality, Lieutenant Stamm's test appeared to be a test of nerve fatigue. When certain other tests were added which he (Colonel Flack) made his particular hobby, and also perhaps the "emotive" test, to which the lecturer had referred, a man would have to be singularly keen and have an enormous amount of "guts" before he would come up to get into the Air Force! With regard to the "emotive" test, he took down to Professor Waller some "wash-outs"—a sturdy fellow whom he thought might be heavy handed, a "windy" man and a mediocre man. They came out well. It was only on the score of expense and lack of time and the fact that we had a war on, causing delay in getting galvanometers, etc., that one had not installed Professor Waller's apparatus for testing "emotivity" in pilots. He believed there was a great future for it. As Lieutenant Stamm had pointed out, his tests were particularly suitable for the selection of pilots in war time. When the research was taken up it was of great value, but, with the onset of commercial aviation, there was not the same necessity for the selection of men of such quick decision as were required for fighting aviators. Commercial aviation would involve safe, straight flying, rather than stunting, and a man of slower reflexes—not too slow—would be the safer man and perhaps the man in whom passengers would have more confidence than the more brilliant man. As an instance of the vagaries of the brilliant men, he mentioned that on his first trip in straight flying in France the pilot, when over a town, started throwing him about. He explained afterwards he had got a bit bored and had to relieve the monotony. He thought these tests would have to be combined, and he wished Lieutenant Stamm had gone into his (Colonel Flack's) physical tests in detail. In the future the question of wear and tear would be of supreme importance. In passing a man

as fit for flying something more than a medical opinion was necessary; it must be based on figures, and, with that end in view, he had modified old tests and devised new ones which he believed would be of use, and he gave a paper on that subject at the Royal Society of Medicine on the previous Friday. The tests he recommended were simple, and could be applied by any medical officer of average intelligence. They could overhaul a man from time to time, and instead of some weak definition, such as " pulse poor " or something which conveyed little to the next medical man who dealt with the case, they would give definite figures which would state their condition as clearly as a technical officer stated the capacity of an engine as so many revolutions per minute. A number of tests would have to be prescribed, to which each pilot would have to submit and which would enable an opinion to be given as to whether he could take the air. It did not matter how many research problems were studied or how many tests were devised if the personality of the medical officer were wrong. In that event the application of all research was futile. The future of the Air Force and the safety of all pilots depended largely upon having temperamentally fit medical officers.

Sir MACKENZIE CHALMERS asked why pilots were chosen so young. The average age of the best polo players was above 30, the average age of the men in the two elevens in the " Gentlemen and Players " at Lords was about 30, and steeplechase riders were from 28 to 36. Why were very much younger men selected for aviation, which involved somewhat similar nervous reaction? Was Captain Stamm's apparatus a fair test between two candidates, one of whom might be used to playing with keys, such as a pianist or a typist, and the other may not have touched a key before? The former would be used to applying his fingers almost automatically to the right keys.

Dr. THURSTON, R.A.F., said he congratulated the lecturer upon the initmate way in which he appeared to have entered the life of the Royal Air Force. The paper was full of valuable suggestions that would appeal to those in authority. The suggestion that every aerodrome should be provided with stables would appeal to every flying officer. Horse-riding was the finest exercise on earth, and a gallop before breakfast was a gift of the gods. Moreover, horse-riding developed judgment and decision of character, and gave one a *joie de vivre* which made a man a better pilot. He would not suggest that a horseman *per se* was the best pilot, but a man of mechanical ability who was also a horseman made an excellent pilot. He congratulated the lecturer on the intimate way he had acquainted himself with Air Force colloquialisms. His knowledge of " binges " appeared to be of a practical nature. He (Dr. Thurston) could tell the audience what the effect of a binge was. One of their men was ordered overseas a few months ago, and a celebration to speed the parting guest took place at lunch, with champagne. Afterwards they went on with their job of instructing pupils. One instructor went up, unconscious of the fact that he had left his pupil behind, and flew round the aerodrome for three-quarters of an hour, made several landings, talked into the speaking tube until he was red in the face, and when he landed in the sheds and found he had flown without a pupil he wore that furtive, apprehensive look which the doctors described. The mechanical stress placed upon the human mechanism in the air was sometimes extremely heavy. He remembered an occasion when an experienced war pilot fainted while carrying out a violent evolution over the *camera obscura*. During the turn he was making centrifugal force acted with 4½ times gravity. He recovered consciousness before he struck the ground, and landed safely. As showing his pluck, he went up again immediately, did an even more violent turn, fainted again, recovered consciousness again, and landed safely. Some years ago, when investigating the possibilities of the human mechanism to withstand centrifugal force, he was swung round in a cage at the end of a long steel cable. The centrifugal force was 6.85 times gravity. He was able to give the signal to stop before he became unconscious and fell to the bottom of the cage. He recovered consciousness at

three times gravity. After lunch he went on again, but was satisfied with three times gravity. Fuller data of the human mechanism would enable better machines to be designed. A crash did not prove or disprove the value of the apparatus the lecturer described. A few successful crashes gave a pilot confidence. They came from so many causes, such as engine failure, getting lost in snowstorms, mists or fogs, and sudden gusts on landing. On one occasion he had an engine failure, and was nearly into the North Sea, but managed to get down on a boggy piece of land. On another occasion, when flying over London in a fog, the engine failed and he got out over the country. The fields were criss-crossed with hedges and full of oak trees. He remembered that the fellow who came out of a crash all right was the one who went on straight. There was a hedge in front of him, and he went through the hedge and got out comfortably. Sometimes crashes occurred through machines having been re-rigged. The control cables might not respond exactly the same and caught the pilot napping. Therefore he did not think it desirable to attach too much weight to the fact that a fellow had had a good many crashes. A machine which had been re-rigged was found tail-heavy, and the machine could not be got down until the passenger climbed along the fuselage till he was up to the engine, which altered the centre of gravity and enabled them to glide safely back to earth. With regard to the kinesthetic sense—the sense of equilibrium—this power of balance was given by the three semi-circular canals in the ear containing a fluid which acted as a spirit-level. A good binge affected the sensibility of the nerves in that canal and giddiness resulted. There were two methods of making vertical turns. The correct method of making vertical turns was to get the machine into the correct position by the rudder, but some pilots kept the rudder still and corrected the machine by the joy-stick. If the kinesthetic sense were highly developed, the correct bank could be got even in a cloud. He had found the method of correcting the machine by the joy-stick the better way, because the body automatically took the correct bank and the joy-stick was pulled with it. The kinesthetic sense should be more highly developed in pilots. After a heavy day's work a man's personal equation or reacting time would be longer, and if he were highly stressed by certain work he could not do as well in the tests as he would another time. Had the Doctor tested ladies and middle-aged and old men with the apparatus? He thought ladies would make good aviators, and also that middle-aged men would make valuable pilots. Flying in a straight flight was more natural than cycling or sailing, and did not affect the human mechanism so much. The spirit of a man might place him above everything. The courage, courtesy, and compassion of our Royal Air Force had made it the envy and admiration of the whole of the civilised world. This spirit could not be gauged by any instrument. The Huns made a mistake when they made their pilots out of N.C.O.s, with the officers as leisured passengers. They lacked our pride and our spirit of devotion and self-sacrifice, and that power of individual adventure which flowed in the blood of the British race. That spirit of adventure would drive us into commercial aviation and make it a success. We had that quality which would make us as great a success in the air as we had been on the sea.

Captain RIPPON, R.A.F., said one rather looked to the Royal Aëronautical Society to give a lead in connection with such things as commercial aeronautics. The avoidance of crashes was largely a question of endurance. The majority of the crashes that occurred took place in landing after long-distance patrols. The pilots came back to the aerodrome and crashed, and the inference was that in consequence of fatigue the pilot was unable to estimate distance. The matter had been investigated by Major Clements, eye specialist, attached to the Royal Air Force. He was investigating particularly the question of vision in connection with landing. In to-night's paper they read that Mr. Handley-Page proposed to make a flight from London to the Cape. The pilot who made that flight would obviously suffer from fatigue. The tests made in the Air Force in regard to

fatigue, on the lines laid down by Colonel Flack, had invariably been successful. He had tested men after a 10-hours' flight, with a couple of forced landings, and who said they had no fatigue that they could feel, but who showed definite fatigue by the Flack tests. A man who had had a forced landing in the Channel showed such marked fatigue by the Flack tests that he (Captain Rippon) told the despatch officer he was not fit to fly. A "D.N.5" had to be taken to France that day, and the man referred to was asked to take it as a favour. He was brought back in an ambulance, and the fact that he last remembered flying over a town 30 miles from the place where he was picked up showed he must have been partially unconscious, owing to cardial vascular fatigue. The lecturer's methods as applied to the candidates who appeared in 1917 to 1919 worked out extraordinarily well, but how many of the pre-war aviators would pass present Air Force tests? However, they were full of that determination and keenness which overcame physical defects. The 1914 class of R.F.C. officer had to pay his own fees to learn to fly, and they had no medical examination, so far as he knew. The finest class of aviator the world had seen was the 1915-16 class. If they did not go solo in four hours they were turned down. He had known them to go solo after three-quarters of an hour dual. They volunteered for aviation, went before a pilot, who asked them what school they had been to, and what games they had played, and, from their career as a boy, he was able to judge their aptitude for aviation. From 1917-19 they were getting near the end of their tether in regard to pilots. Out of 45 cases which he took as a sample, 22 were clerks, 11 engineers, and of the rest about five were students, one a farmer, and the rest draughtsmen or something like that. It was in that class that the reaction time test came in, as it was necessary to pick the men who had the "guts." Lieutenant Stamm's simple reaction time test was not of as much value as his "dilemma," which was extremely valuable. He had seen a man put into a steel case and the air evacuated to the equivalent of the air at a level of 20,000ft. His reaction time was taken at that point and again after he "came down." His reaction time had been lengthened from .195 to .2, and his auditory reaction time had been lengthened even more, so that the simple reaction time test gave useful results in dealing with simple reaction times. But it was not so much the time as the variation from the mean. The reaction time of a pilot who had had a crash varied, so that instead of being an average of 19/100ths to 20/100ths of a second, it was 30/100ths or even 40/100ths, and then went back to 19/100ths.

The CHAIRMAN said the paper was of considerable importance, especially from the point of view of the physiologist and psychologist. One could not help feeling that Mr. Stamm was perfectly aware that this reaction time test and some of those which might be called confusion tests were not the only guides which should be adopted for the determination of the fitness or unfitness of flying men. He had made it clear that the personal equation could not be determined by the mere estimation of reaction periods, but such a condition as Captain Rippon mentioned was no doubt very much present to his mind. It was difficult for the reader of a paper in a short time to deal with his whole subject. He was only dealing with one important part of the subject which should enable them in the future, with further investigation, to determine the fitness of people for flying. He (the Chairman) was a member of a Committee dealing with important aviation problems, and they had already had expressions of opinion that the commercial pilot of the future would not be exactly the same kind of man as the fighting scout, but the fitness or unfitness of an individual for commercial aviation must be determined on scientific grounds. They were only on the threshold of this inquiry, and a great deal of work had to be done on the subject, which was of intense interest to the physiologist and of immense importance so far as the safety of the public was concerned. When commercial flying became established as a definite industry the people would require that there should be a body which would determine the conditions which made for safety and that

inquiries should take place as they now took place into railway accidents. The safer commercial aviation became the more certain it was of becoming successful. The medical profession could contribute an enormous amount—especially the physiologists—to the determination of fitness for this class of work. He concluded by proposing a vote of thanks to the lecturer, which was unanimously passed.

Dr. STAMM, replying to the discussion, said, in regard to Sir Mackenzie Chalmers' questions that those gentlemen who excelled in sports in the late '20's and '30's probably did not take them up at that age. They had passed through their apprenticeship at a much earlier age. He did not think there could be much doubt about the desirability of a fellow learning to fly at the earliest opportunity—at any rate, when he had passed puberty and could be said to have more or less developed to manhood. Medical men were enormously impressed with the adaptability of youth. He was sure it had taken him longer to learn to fly than it would have done 20 years ago. Boys should be encouraged to learn to fly early, but whether they should be given responsibility as either war or ferry pilots till they were well in their twenties was questionable. He had not found pianists or typists excel on the chronoscope. A wireless telegraphist was only up to the average. Flying pupils and pilots who were neither pianists, typists, nor wireless telegraphists, but who had extraordinarily quick intelligence, had secured top marks. Colonel Flack had raised the question whether such quick reaction was necessary in civilian pilots, but the apparatus also tested for accurate results. One preferred a slow reaction—somewhere in the '40's—without mistakes to a very quick reaction with many mistakes. In the case mentioned by Captain Rippon of the test on the man who had been up to 20,000ft., the simple reaction time test was useful as an indication of the condition of the nervous system, but his point was that the simple reaction time was not of value as a test of the mentality of a person, because a person might have a good mentality and all the necessary mental qualities to make a good pilot and yet have a slow reaction time for the simple test. With that type, although the complexity of the problem was increased, the time was not increased to the same extent as with other people. They started slow, but finished, with the four signals, at top speed. He had tested a few ladies, and for the most part the results were satisfactory. They were certainly up to the average, but none of them had capped the crack pilots' figures. With age the reaction time definitely lengthened, though some slowed down earlier than others.

A vote of thanks was accorded Sir Alfred Keogh, on the motion of Sir MACKENZIE CHALMERS.

ABSTRACTS.

The Aeroplane in Curvilinear Flight.

The article describes an investigation into the attitude taken up by an aeroplane in curvilinear flight. It is admittedly only a very approximate method, assumptions being made in order to simplify the mathematics. When an aeroplane turns, it banks, and if the banking is excessive the machine side-slips inwards, the opposite being the case if the angle bank β is not large enough. First of all the author examines the relation between β and other quantities, defining the machine and the motion.

If ρ be the radius of curvature of the path, V the velocity, then the angle of bank β is given by $\tan\beta = V^2/\rho g$, assuming the sine law for the resistance of the planes.

A few remarks are made on the gyroscopic effect of the airscrew either in assisting or opposing the banking movement, together with a consideration of the difference in the lifts on the two wings due to the circular motion.

The effect of the angle of the rudder is next examined, and an expression is derived for the radius of curvature of the path. If F_s be the area of the rudder, and α the initial value ($t=0$) of the angle through which the rudder is turned, then the component forces acting on the rudder parallel and perpendicular to the longitudinal axis of the machine are respectively—

$$R_s = v^2 F_s \sin^2\alpha\psi\gamma/g,$$
$$A_s = v^2 F_s \sin\alpha\cos\alpha\psi\gamma/g,$$

γ=the density of the air and ψ a constant coefficient. The latter force produces a moment about the vertical axis through the C.G. and if the average be l, M can be written in the form

$$M = C\sin 2\alpha,$$

C being assumed constant and equal to $\psi\gamma l v^2 F_s/2g$, and the moment produced by R_s neglected in comparison with M. Further neglecting the opposing moments due to difference of the relative speeds of the outer and inner wings the equation

$$\frac{d^2\phi}{dt^2} = \frac{C\sin 2\alpha}{J}$$

is obtained where ϕ is the angle between the original rectilinear flight path and the axis of the machine at time t, and J the moment of inertia about the vertical axis through the centre of gravity.

On integration this gives the angular velocity

$$w = \frac{C\sin 2\alpha}{J}t$$

and the angular displacement $\phi = C\sin 2\alpha t^2/2J$, and since $\phi = vt/\rho$,

$$\rho = 2vJ/C\sin 2\alpha t.$$

In actual flying the banking of the machine due to difference in the speed of inner and outer wings will cause the machine to " take the curve " and the centrifugal force will balance the lateral force so as to do away with side-slipping.

It is admitted that the above formula for ρ is only a rough approximation, assuming as it does the constancy of α and v. At large values of β, M is usually small; for the extreme case $\beta = 90°$, it vanishes. J also ceases to be a principal

moment of inertia for values of β other than 0° or 90°. Still it is claimed that the approximation is good for the values of β up to about 25°.

Further

$$\tan \beta = \frac{v^3 F_s \,.\, t \sin 2\alpha}{4gJ}$$

Finally a few calculated values of β are given for $\alpha = 5°$ and 10° and for values of t varying between $t = l$ and 20 seconds, and the personal element introduced into the control of the machine is discussed. ("Schweiz Aero Club Bulletin," Nos. 8 and 9.)

Influence of Wave Formation upon Aerodynamic Resistance.

The square law of resistance of a body moving in air applies only up to 240 m.sec. At this velocity the resistance co-efficient, obtained by dividing the resistance w by v^2—where v is the velocity of the body relative to the air, increases rapidly until at 480 m.sec. it reaches a maximum about three times its original value. The coefficient then gradually decreases with speed. A. Sommerfeld sought an explanation from an analogy between the waves from a solid sphere moving with a velocity greater than sound and electrons moving quicker than the velocity of light.

For motion of a body through the air with a velocity greater than that of sound, the ratio w/v^2 was taken to be of the form

$$\frac{w}{v^2} = y = K + A \frac{1 - e^2/v^2}{v^2}$$

where c is the velocity of sound (340 m./sec.) and K and A are constants.

For cases where v is less than c it was considered that compressibility affected the density according to the law

$$\mu = \mu_0 \frac{c \,.\, f(v)}{c \,.\, f(v) - v}$$

where μ is the normal density and $f(v)$ a function of the velocity taken to be of the form

$$f(v) = a + bv.$$

The law for the curve y against v then took the form

$$y = \frac{w}{v^2} = B \frac{\mu_0 f(v)\, c}{f(v) \,.\, c - v}$$

v being $< c$.

The constants were chosen to fit a given case. (Dr. Alfred Lechner, "Osterreichische Flug-Zeitschrift," Aug., 1918.)

Limit Performances of Aeroplanes.

The article commences with a discussion of the utility and futility of helicopters, and concludes from aerodynamic and stability considerations that the introduction of such a new type of dynamic aircraft is neither advantageous nor desirable. Proceeding to an analysis of the limiting range of an aeroplane the writer commences with a consideration of certain properties of wings, and points out the desirability of an accurate definition of what is meant by the chord of an aerofoil, and consequently also by the angle of incidence. He supports the view that the latter should always be measured from a position of zero lift, because only thus is a sensible comparison between the properties of different aerofoils possible. The problem of maximum flight endurance or of the greatest distance

which an aeroplane can fly without re-fuelling is shown to depend ultimately on the efficiency of propellers, the L/D of the machine, the fuel consumption per horse-power, the ratio of useful load to total weight. The following conclusions are then drawn:—

(1) The maximum distance which an aeroplane may cover in the near future without re-fuelling may be estimated at 4,500 km., sufficient for crossing the Atlantic from Newfoundland to Ireland.

(2) The rational solution of the trans-Atlantic flight is furnished by the single-screw multi-engine aeroplane, which has the great advantage over all other existing types of being characterised by a decrease in drag and specific weight with an increase in size. With such an aeroplane the Atlantic could be crossed within 30 hours.

(3) The development of a propeller endowed with high efficiency and means for absorbing variable power is an additional important factor. (G. de Bothezat, "Aviation," Oct. 1, 1918.)

German Hannoveraner C.L. II.

This machine is a light two-seater for general use. Precise details have been lacking for some time; it first made its appearance in January of 1918.

The principal dimensions are as follows:—

Upper wing span	39.2 ft.
Lower wing span	36.7 ft.
Total length	25.6 ft.
Height	9.4 ft.
Lifting surface	347 sq. ft.
Total weight	2,545 lb.

The wings are unequal in span and chord. There is a dihedral of 1-1/2° on the upper and 2-1/2° on the lower plane, and the lower wings are swept back 1-1/4°. The ailerons are of steel tube framework and balanced; they are operated by cables in the interior of the lower plane.

There is a central plane to which the upper wings are attached. In the thickness of this central plane are a honeycomb radiator and a petrol tank. The amount of cooling surface of the radiator in action is adjustable by means of a pivoted metal plate, and there is a level indicator on the petrol tank. The central plane is covered with 3-ply.

The wing struts, of which there is one pair on each side of the body, are of steel tubes in a faired sheath. They do not follow the stagger of the planes, and slope outwards laterally from base to top.

The cabane is divergent and consists of three tubes of N-form on each side of the fuselage. The points of attachment of these tubes to the body are very far apart, and the method of attachment does not appear to be very successful. It has been proved that after a very short time the bolts show wear.

The tail is a small biplane, segmental in plan form, with elevators top and bottom. A single strut on each side of the fuselage is fitted between the planes. The whole consists of a framework of steel covered with fabric. The lower tail-plane is divided by the fuselage and the fixed fin and the rudder extend as far as the top plane.

The fuselage is entirely of wood, and ends in a vertical knife edge forming the rudder post. The front portion is very deep and nearly fills the gap between the wings. The two cockpits are separated by 22 cm. only.

The motor is a 200 h.p. new model Opel, with six cylinders in line.

The Hannoveraner C.L. II. can fly for 2-2½ hours, and its ceiling is 19,700 ft., which it reaches in about 45 minutes. Its speed is 100 m.p.h. at 6,500 ft., and 90 m.p.h. at 13,000 ft.

In the opinion of pilots who have flown it, the machine is very sensitive to the controls.

The Hannoveraner C.L. III. preserves the general characteristics of the C.L. type II. In it the cross bracing between the tailplanes is replaced by two small flattened tubes, each extending from the base of the fixer fin to the top of an inter-plane strut. ("L'Aérophile," Oct. 1-15, 1918.)

Meteorological Conditions and Flying.

The author suggests that the chief conditions that increase the risks of flying are (1) gales, (2) squalls, (3) bumps and eddies, (4) clouds, (5) rain, hail and snow, (6) fog, (7) lightning. While strong winds are not now as formidable as heretofore, danger is to be anticipated when these arise with great suddenness. The author remarks in illustration that at Farnborough an anemometer 140 ft. above ground-level registered a velocity of 80 miles per hour, when only a quarter of an hour previously the air had been quite calm. Considerable damage was done on that occasion to hangars and tents. But in general a gale may be forecasted many hours in advance, from the weather map for the day. Squalls, on the other hand, which are usually associated with thunderstorms, are frequently a much graver danger since they are often preceded by very light winds or even complete calm, and within a minute from their onset may be blowing 60-80 miles per hour.

A particularly dangerous form is that known as the line squall; this extends usually only a few miles across, but may be several hundred miles long, and advances across the country broadside on at 20-40 miles per hour. Besides the blast of wind in front of the squall there are great up-currents in front, and down-currents near the middle, with violent eddying between. It is suggested that warnings of the approach of these dangers could be carried through by telegraphic communication from aerodromes to a central office.

Bumps are mostly due to rising currents of air over surfaces of the ground that are of different temperatures, and to eddy motion due to the wind blowing over irregularities of surface. They are also associated with cumulus clouds. The cumulo-nimbus clouds being associated with heavy rain and possible hail, or with snow in winter, may prove extremely dangerous; they usually constitute a sea of very rapidly ascending currents.

Low sheets of clouds may prove a hindrance to work with aeroplanes, and if they are exceptionally low, may cause difficulties for a pilot in returning to an aerodrome or even in landing. (C. J. P. Cave, "Aerial Age Weekly," Sept., 1918.)

Determining Direction and Velocity of Wind by Sound.

The method was originally invented solely for artillery purposes, but it will become, in the opinion of the author, General Bourgois, one of the best methods for the investigation of meteorological problems, and is applicable in cloudy weather. Before the war, meteorologists considered the determination of the velocity and direction of the winds at high altitudes very important with a view to forecasting the weather conditions. During the war this knowledge became of paramount importance with relation to the flight of aeroplanes and for the calculation of the range of shells, which at the summit of their trajectory come under the influence of currents hitherto unknown. The knowledge is necessary at night, and in foggy or cloudy weather, as well as during daylight, when the movement of clouds is observable. The new method known as "sound-ranging" was brought into use by the military meteorological office in 1917.

The method consists in allowing a balloon filled with hydrogen to rise freely, and be carried by the various currents of the atmosphere. This balloon carries small shells, which burst at regular intervals. Certain apparatus register the

explosions, and these enable the position of the balloon to be accurately determined. These points are then plotted, and the trajectory or course of the balloon is traced. The sum of the projections on a horizontal plane of the positions at which the explosions took place, and the knowledge of the time intervals between these explosions enable the velocity and the mean direction of the wind to be determined between certain altitudes.

The balloons used are 1 m. to 1.30 m. diameter, and the shells are charged with melinite, the weight of a shell being about 200 gr. In spite of the smallness of the shells the explosions can be heard at distances up to 15 kilometers, even with a contrary wind having a velocity of over 10 m. per sec. The results obtained will be published completely by the geographical department of the army, and will be compared with those obtained at the German observatory of Lindenberg, where captive balloons and kites were employed. Sound-ranging has been possible every day, whereas a captive balloon could only be used on 91 days in the year at Lindenberg.

The balloon and kite method is rarely available at heights exceeding 5,000 m., and the record for a balloon is 7,058 m., these heights are readily attained by the sound-ranging balloons, and heights of 8,000 to 10,000 m. have been reached experimentally. The little hydrogen balloons can be used in winds having a velocity of 35 m. per sec., whereas this is quite impossible with either the captive balloon or kite. Teisserenc de Bort divided the atmosphere into two parts, the troposphere and the stratosphere. The former, which has a mean depth of 10 to 12 km., should be the region of vertical currents and the phenomena which control the climate in our countries. Sound-ranging gives for the first time a means of exploring completely this most important part of the atmosphere. ("Comptes Rendus," Nov. 25, 1918.)

Dopes, Doping and Ventilation.

The principal feature of this article is the description of the system of drying in cabinets, as invented by the writer. In order to prevent "blushing" of the doped surfaces during the drying process, it is necessary to keep the relative humidity of the drying-room below 50° F., blushing being due to condensation of moisture on the film of dope. The employment of cabinets for drying obviates the need for a high temperature work-room which would be trying for the workers. The cabinet system is much less expensive than the system sometimes employed of combined cooling and heating ventilation of the dope-room. The drying chambers or cabinets are steam-heated to a temperature of 105° F. under ordinary weather conditions. Gratings in the floor carry off the heavy fumes. About five changes of air per hour are necessary for the cabinet. Partitions forming the cabinets may be simply framed and covered with close mesh muslin and given two coats of calcimine to make them airtight. (F. A. Leedy, "Aviation," Nov. 15, 1918.)

Production Problems of Aircraft Bolts, Screws and Nuts.

Superintendent Sheahan gives an account of the special difficulties which attend the manufacture of such small aircraft parts as bolts, screws, and nuts. The average bolt and nut maker, who turns out his products, the bolts by the heading process with rolled threads, and the nuts by the punched method, is warned that he is absolutely unfitted to undertake contracts for small aircraft parts.

A number of the difficulties arise from the fact that the 3-3½ per cent. nickel steel, commonly used in the aeronautical industry, is undoubtedly one of the hardest steels to machine properly, and it is of vital importance that no ring scores circle the bolt, stud, or turnbuckle shank.

Aeroplane constructors generally specify heat treatment of the nickel steel, which increases the tensile strength from 50 to 100 per cent., followed by die

sizing of the threaded portions to a basic pitch diameter with a tolerance of 0.002 in. The precautions to be taken in die sizing after heat treatment are mentioned. But the writer does not see why the pieces should not be threaded to the required tolerance before the heat treatment, which, if carried out in the proper manner, can be done without the formation of any scale on the thread, and without any appreciable change in the dimensions of the piece. If this practice were adopted threads of greater strength would be obtained, and there would be a considerable economy in manufacture.

Attention is drawn to the enormous difference in the cost of manufacture of parts made of alloy steel of high tensile strength, and those made of the ordinary carbon steel. Col. R. K. Bagnall Wild's estimate of five times for alloy steel as against carbon steel is quoted, together with the statement that for alloy steel several operations are necessary which are quite overlooked by the manufacturer with experience of only carbon steel, and that the cost of various operations, such as " burring " heads of bolts after machining, is additional to Col. Bagnall Wild's estimate.

Although not simple, the manufacture of bolt nuts is not attended by so many difficulties as in the case of bolts. The tapped size should in no case exceed the basic pitch diameter by more than 0.002 in. in the larger sizes, while 0,005 in. is a liberal enough tolerance for the smallest nuts. The size of tap drill should be chosen so as to give a thread about 75 per cent. of the full depth. This gives a margin of safety of about two to one in favour of the nut not stripping as against the breaking of the bolt. Even a 50 per cent. thread will break the bolt before the thread will strip.

The commercial taps on the market are generally not made to tap to the fine tolerances required, and manufacturers consequently generally make their own taps. Some information on this point is given. Castellation of the nuts may be done by means of a special attachment on the automatics, but it is more quickly done as another operation on other machines.

The methods of gauging bolts and nuts are given; manufacturers are recommended to gauge their bolts on production by " snap " limit gauges, in which the bolt is applied to the gauge and not *vice versa*. The weight of the bolt then decides if it is a " go " or a " not go." (" Aviation," Oct. 15, 1918.)

Sheet Metal Aeroplane Fittings.

Aeroplanes require a large number of metal fittings entailing considerable work. Many are built up of combinations of sheet metal stampings, or of forgings and stampings.

Oxy-acetylene is employed largely for welding the parts together, but some fittings are brazed. A socket for the front upper end of the landing gear strut is shown, consisting of three sheet metal parts, welded together, and a more complicated piece comprising one of the horns that go on top of the wing. A much larger piece is the nosepiece that goes at the front of the fuselage; this is formed out of sheet metal with a large number of openings, the edges of which are bent inwards, and finally the whole sheet is folded in a very complicated manner. The flanging is at present done by hand, but it can be easily seen from the illustrations that the use of dies for bending would reduce the cost if the demand became great enough. (" American Machinist," Oct. 19, 1918.)

Aerial Postal Service.

A trans-Adriatic aerial postal service has been established between Venice and Ancona, and Trieste, Fiume, Porenzo, Zara and Pola. A service will shortly be established between Brindisi and Dalmatia. (" Giornale d'Italia," Nov. 20, 1918.)

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ABRIDGMENTS OF RECENT PATENT SPECIFICATIONS (AERONAUTICS).

COMPILED BY MR. H. T. P. GEE, PATENT AGENT.

119,944. D. S. Crowther, Hay Green, Kingston Hill, Surrey, and W. Routledge, 4, Laurel Bank, Hoop Lane, Golders Green, London. November 26, 1917.

Screw Propellers.—Each blade is built of a series of layers of wood, vulcanised fibre, papier-mâché, or the like substantially parallel to its helical surface. The strips of wood, etc., are made preferably with the outside strips, tapering from end to end, whereby the joints between the strips run diagonally across the propeller. The strips or layers are placed in a former and cemented together to form a laminated propeller. In one form a layer is made of a single piece of wood slit longitudinally to form a series of adjacent strips. A series of these layers are moulded on a former and secured to a wood boss having a central metal bush. The boss may be of aluminium and fitted with wings, which may in some instances take the form of frames extending entirely around the edges of the blades. The blades are clamped, riveted, or screwed to the boss. The rear face of the blade is thickened by wood, etc., layers, or by a shaped metal plate.

119,967. Lang Propeller, Ltd., Weybridge, and C. A. Laing, New Malden, both in Surrey. January 14, 1918.

Screw Propellers.—Each lamina of an aeroplane propeller consists of strips of wood formed from waste cuttings having tongue and grooved or like joints fixed by glue or other adhesive. A number of rough laminæ are glued or otherwise united to form the block from which the propeller is shaped.

119,974. Blackburn Aeroplane & Motor Co., Olympia, and H. Booth, 5, Oakwood Avenue, Roundhay, both in Leeds. January 24, 1918.

Planes, Arrangement and Construction of.—Tail fins for aeroplanes and other aircraft are constructed with two vertical spars extending into the fuselage, either the front or rear spar being laterally flexible and the other spar rigid so that the effectiveness of the fin shall be respectively increased or diminished with increase of speed. The drawings show a fin having a flexible rear spar and rigid front spar extending into the fuselage. A rudder is pivoted to the rear edge of the fin.

120,150. C. E. Lee, 23, Medlar Street; G. Fellows, 115, Camberwell Road; and C. A. Pratt, 56, Bovingdon Road, all in London. January 14, 1918.

Screw Propellers.—In order to economise material and to prevent warping, wooden propellers are made by glueing together layers, parallel to the plane of rotation and perpendicular to the axis of rotation, consisting of strips running lengthways of the blades, alternately separated by layers the grain of which is transverse to the longitudinal strips. The transverse layers may consist of a number of narrow strips laid side by side.

120,192. G. A. A. Leinekugel le Cocq, Chateauneuf S/Loire, Leiret, France. March 12, 1918. Convention date, October 23, 1917. Net yet accepted. Abridged as open to inspection under Sect. 91 of the Act.

Shelters for Aircraft.—A hangar for dirigibles comprises two main suspension girders formed of cables or chain bars carried at their ends by four braced uprights

and supporting transverse roof trusses, the roof thus being independent of the walls. The longer sides of the hangar are closed by movable partitions or doors which travel on rails and can be placed adjacent to the ends to form a windscreen on either side for the entrance and exit of the dirigible. The end walls may be closed by fixed or movable partitions.

120,253. R. R. Walls, 15, Victoria Street, London. October 30, 1917.

Telephone Apparatus; Speaking Tubes.—The helmet or headgear of an aviator's or like acoustic transmission apparatus is fitted with an earpiece or earpieces adapted to enter the ear passage and to fit closely against the ear. As shown in the drawings, the earpiece comprises a flange of rubber or like material provided with a flexible tubular projection for insertion into the ear passage, and with a connecting piece to receive a flexible speaking tube, the opposite end of which is fitted with a mouthpiece. The flange is fitted to and embedded in the helmet and forms a sound insulator and ear protector. The mouthpiece is shaped to fit the face and is edged with rubber, leather, etc. When not in use it is suspended in a bracket. In a modification the connecting piece is omitted and the flange is shaped to fit over a telephone receiver carried by a head-band. The earpieces may communicate with telephone receivers by flexible tubing, or with the earpieces and mouthpiece of another headgear.

120,275. W. H. Davis, 46, High East Street, Dorchester. November 9, 1917.

Clinometers.—An inclinometer for aircraft, stated to be unaffected by centrifugal and other accelerating forces, comprises two pendulums swinging on a spindle and connected respectively to the toothed ring and the planet cage of an epicyclic gear, and a pointer indicating on a dial and fixed to a sleeve secured to the sun pinion of the gear. One or each of the pendulums may extend above the spindle and carry a weight adjustable in position thereon. Means for damping oscillations may be provided, and may comprise two light blades secured to the sleeve.

120,298. S. E. Saunders, White House, East Cowes, Isle of Wight. December 19, 1917.

Aerial Machines with Aerostats; Aerostats; Steering and Balancing.—The envelope of an airship is constructed of two or more wood laminæ stitched together as described in Specification 105,412 and secured upon longitudinal ribs connected together at intervals—for example, by bracing and cross-wires or by radial bracing of laminated wood. A layer of silk, etc., may be inserted between the laminæ. Adjustable propellers and planes are provided at the sides for forcing the ship down against the buoyancy of the gas or to assist the ascent. Water may be pumped between ballast tanks for adjusting the balance. A keel may have chambers which may be filled with water to retain the ship floating upon the water when forced down against the buoyancy of the gas.

Cars and Cabins.—Cabins are provided within the envelope and are connected by a passage way to a front cabin. The cabins and passage are provided with double walls to contain nitrogen or other inert substance to reduce danger of fire.

120,311. C. A. Johansson, 60, Brinkens Gate, Christiania. January 29, 1918.

Steering and Balancing.—Unintentional lateral deviation of an aeroplane from its course, and the consequent banking, are automatically counteracted by auxiliary planes controlled by the inertia of a bar provided with two pivots, one or other of which serves as a fulcrum according to the direction in which the

aeroplane tends to turn. The bar is provided with weights and the pivots are carried by slides moving in curved guides, the movement being limited by slots. Pins on the slides engage at opposite sides of arms on the auxiliary planes. When the aeroplane begins to turn the weight at the outer side lags behind and sets the auxiliary plane at that side to a negative incidence. In a modification the weights are replaced by a single weight arranged at the end of an arm extending rearwardly from the bar.

120,450. Blackburn Aeroplane & Motor Co., Olympia, and H. Booth, 5, Oakwood Avenue, Roundhay, both in Leeds. November 15, 1917.

Fuselages; Boats; Floats.—A fuselage, boat, or float in the form of a hollow elongated cone or tapering tube, and more particularly for a flying machine, is composed of a plurality of layers of wood planking running lengthways from one end to the other, and of similar shapes and sizes in each layer, the planks being connected edge to edge with the joints in the several layers in staggered relationship, as shown. The grain of the wood of an outer layer may extend in a different direction from the grain of an inner layer, and the grains of adjoining planks in a single layer may run in different directions. In order to obtain planks having the grain at right angles or less to the length, a number of pieces of wood are joined edge to edge to produce the requisite length, and planks are then cut from such compound structure with the grain running at the desired angle.

120,452. J. J. Murray, Forty-Second Street, and Broadway, New York, U.S.A. November 15, 1917.

Cars and Cabins; Framework; Planes, Arrangement of; Land Wheels; Propelling.—The main planes, engine, landing-gear, and, if desired, the seats of aeroplanes are carried directly by two beams extending longitudinally of the fuselage. In the form shown in the drawings two beams arranged within and connected to the transverse members of the fuselage carry the main planes by means of struts, the engine by means of transverse bearers, the land wheels by means of hangers, and the seats by means of further hangers.

120,463. L. A. Stevenin, 19, Glenthorn Road, West Jesmond, Newcastle-on-Tyne. November 26, 1917.

Steering.—The drawings show a device for effecting simultaneous movements of ailerons in the same or opposite directions at will and for controlling the elevators of aircraft. A vertical tubular lever is connected by arms to a transverse member loosely supported in quadrants pivoted about axes. A tube passes through the lever and has a forked lower end universally jointed to a pulley. The upper end of the tube is geared to a handle. The aileron cables are secured to the quadrants and the elevator cables to the pulley. Lateral movements of the lever move the quadrants oppositely, fore and aft movements move the quadrants in the same direction, and movements of the handle turn the pulley.

120,480. Boulton & Paul, Aircraft Works, Norwich, and J. D. North, The Cottage, Burgh Apton, Norfolk. December 29, 1917.

Internal Combustion Engines; Two-Stroke-Cycle Engines.—Aero-engines are supplied with air at an approximately uniform pressure at all altitudes by compressing it by the pump into a reservoir with a spring-loaded escape valve, whence it flows into the engine through a beat valve when the piston uncovers the exhaust ports.